

10/539496  
JC05 Rec'd PCTO 17 JUN 2005

KEIL & SCHAAFHAUSEN  
PATENTANWÄLTE

EUROPEAN PATENT ATTORNEYS\*  
EUROPEAN TRADEMARK ATTORNEYS

DIPL.-PHYS. DR. RAINER A. KEIL\*  
DIPL.-PHYS. LUDWIG R. SCHAAFHAUSEN\*  
DIPL.-ING. NANNO M. LENZ\*  
DIPL.-PHYS. DR. CARSTEN HERBERG\*  
DIPL.-ING. MICHAEL A. DAHMEN\*  
DIPL.-ING. (CHEM.) DR. PHILIPPE R. R. SAUER

CRONSTETTENSTRASSE 66  
60322 FRANKFURT AM MAIN

TELEFON : +49 (0)69 - 95 96 23 - 0  
TELEFAX : +49 (0)69 - 95 96 23 50  
E-MAIL : MAIL@KSPATENT.DE  
INTERNET : WWW.KSPATENT.DE

September 29, 2004  
HL/HAM

Europäisches Patentamt

80298 München

Your Ref. : PCT/EP03/14226  
Applicant : Outokumpu Oyj  
Our file : O 1 P 99 WO

To the Written Opinion dated July 9, 2004

## 1. New documents

Enclosed please find a new set of claims 1 to 17 and new pages 2, 2a, 3, 3a, 6 and 7 of the specification to replace without prejudice the documents as currently on file.

New claim 1 is a combination of claims 1 and 10. New claim 11 is a combination of the original claims 12 and 13. Claims 2 to 9 remain unchanged. New claims 10 and 12 to 17 correspond to original claims 11 and 14 to 19 with adapted references.

In the specification, on page 2, line 8 an identification of the relevant prior art has been included. Further, the paragraph of page 6, line 24 to page 7, line 3 has been transferred to page 3, line 10. On page 7, the last two paragraphs have been combined.

For convenience, an exemplar with marked amendments is enclosed to this letter.

## 2. Novelty

None of the prior art documents show a fluid-pressure conveying line for determining the material quantity of the material fed to the reactor by measuring the pressure and/or pressure loss in the conveying line.

Therefore, new claims 1 and 11 are new with respect to the prior art.

## 3. Inventive step

Document US 5,226,374 is considered as closest prior art. It discloses a method of controlling combustion in a fluidized-bed incinerator comprising measuring a supply rate of incineration waste. When the supply rate of incineration waste is higher than a predetermined value, the supply rate of the incineration waste of the dust feeder is decreased to suppress a combusting operation. Further, i.e. an induced gas rate of an exhaust gas induced blower of the incinerator is increased to suppress an increase in an incinerator internal pressure. The supply rate of incineration waste is measured by a measuring unit using a photoelectric element arranged on a shoot for supplying incineration waste. However, the photoelectric measurement of waste is not very accurate. The accuracy is sufficient for an incinerator of waste. However, for the production of special chemical products, the measurement of the supply rate with the photoelectric element has not the required accuracy in order to control the process conditions in the reactor as constantly as possible.

It is thus the object of the present invention to provide a method for controlling the process conditions, in particular the temperature, in the reactor as constantly as possible to a set point predetermined in relation to the process.

This object is solved with a method according to the features of claim 1 and the plant according to the features of claim 11. In particular, the conveying line of the reactor is a fluid-pressure conveying line, in particular a preferably perpendicularly arranged rising line of an airlift. In such a conveying line, it is possible to determine the material quantity of the material fed to the reactor by measuring the pressure and/or the pressure loss in the conveying line

upstream of the reactor. This measurement is very accurate because by definition all of the material fed to the reactor is considered. In contrast, with a photoelectric measurement, it is possible, that parts of the material are not seen or detected by the optical system. Thus, with the principle of measurement according to the present invention, it is possible to determine the supply rate of granular solid material with high accuracy. Hitherto, the determination of the rate of granular material has been very difficult in contrast to a measurement of the flow rate of fluids for which many different methods of measurement exist.

( ) Document US 5,226,374 does not give any hint for the one skilled in the art to provide a fluid-pressure conveying line with the possibility to measure the pressure and/or the pressure loss in the conveying line. For the aim of the waste incineration, the photoelectric measurement of the supply rate is accurate enough.

( ) Also the further documents cited in the International Search Report do not lead to the invention according to the present application. JP 55140008 (Patent Abstracts of Japan) describes a high accuracy control of temperature by measuring the temperature in the fluidized-bed and controlling the amount of floating medium forming the fluidized-bed in order to adjust the temperature. However, in this document the temperature in the reactor itself is measured and then the supply rate of medium is adapted to control the temperature. By measuring the temperature in the reactor it is only possible to react to a deviation of temperature in the reactor. With the present invention, however, fluctuations in the temperature of the reactor are avoided by measuring the quantity of material supplied to the reactor in advance and using this quantity as control variable and/or disturbance variable in order to achieve that the process conditions in the reactor do not change.

Same applies to document EP 0 093 063 A1 in which a temperature control of a fluidized-bed reactor is described measuring the temperature in the fluidized-bed of the reactor and varying the temperature of the material transported into the reactor by mixing up material out of two conduits with higher and lower temperature. Also in this case, no material quantity transported in a conveying line is measured. A similar method is employed in document WO 96/18076 A1 describing a gas cooler having a circulating fluidized-bed. Hot gas is introduced into a mixing chamber where it is mixed with solids having a temperature lower than that of the gas, whereby the temperature of the mixing chamber settles to a mixing tempera-

**Patent claims:**

1. Method of controlling the process conditions, in particular the temperature, in a reactor (1) of a plant into which, in particular, granular material is introduced and transported through a conveying line (14) to the reactor (1), the material quantity transported in the conveying line (14) being determined and being used as control variable and/or disturbance variable for controlling the process conditions, in particular the temperature, characterized in that the material quantity of the material fed to the reactor (1) is determined by measuring the pressure and/or the pressure loss in a conveying line (14) upstream of the reactor (1), in particular in an airlift (13).
2. Method according to claim 1, characterized in that the material quantity in the conveying line (14) is controlled to a predeterminable value.
3. Method according to claim 2, characterized in that the material quantity in the conveying line (14) is controlled by a conveyor (27, 33), with which the material is introduced into the plant, in particular by varying the rotational speed of a material-charging screw (30) and/or by a weighfeeder (34) upstream of the material-charging screw (30).
4. Method according to one of the preceding claims, characterized in that the heat supply to the reactor (1) depends on the material quantity determined.
5. Method according to claim 4, characterized in that the heat supply is effected by burning fuel in the reactor (1) and the fuel feed is controlled for controlling the heat supply.
6. Method according to one of claims 4 or 5, characterized in that the reactor temperature is measured in the reactor (1) and the heat supply additionally depends on the reactor temperature determined.

7. Method according to one of claims 4 to 6, characterized in that the time from the determination of the material quantity until the feeding into the reactor (1) is taken into account in the control of the heat supply.

5 8. Method according to one of the preceding claims, characterized in that a material discharge, for example via a bypass line (24), between the determination of the material quantity and the feeding into the reactor (1) is determined if need be and is taken into account in the control in particular of the material quantity and/or of the heat supply.

10

9. Method according to one of the preceding claims, characterized in that the material is dried and/or preheated before the determination of the material quantity in the conveying line (14).

15

10. Method according to one of the preceding claims, characterized in that a gas/solid suspension forms in the reactor (1), for example as a circulating fluidized bed.

20

11. Plant for the heat treatment of material fed to a reactor (1), in particular for carrying out the method according to one of Claims 1 to 11, having a conveying line (14) for the transport of granular material to the reactor (1) and having at least one control (5, 31), and a measuring device (12) which is connected to the control (5, 31) and is intended for determining the material quantity of the material transported in the conveying line (14) to the reactor (1), characterized in that the conveying line (14) is a fluid-pressure conveying line, in particular a preferably perpendicularly arranged rising line of an airlift (13).

25

12. Plant according to claim 11, characterized in that the measuring device (12) is a differential-pressure measuring device for measuring the differential pressure over the conveying line (14).

5 13. Plant according to one of claims 11 or 12, characterized in that the control is a temperature control (5) and/or a material-charge control (31).

14. Plant according to claim 13, characterized in that a temperature sensor (8) connected to the temperature control (5) is arranged in the reactor (1).

10

15. Plant according to claim 13 or 14, characterized in that the temperature control (5) has a control element (6) for controlling a fuel mass flow, directed to the reactor (1) for the combustion, on the basis of the determined material quantity and/or the measured reactor temperature.

15

16. Plant according to one of claims 13 to 15, characterized by a conveyor (27, 33) which is connected to the material-charge control (31) and is intended for the controlled introduction of material into the plant, so that the material quantity in the conveying line (14) can be set to a predeterminable value.

20

17. Plant according to one of claims 11 to 16, characterized by at least one drying device (18, 26) upstream of and/or downstream of the conveying line (14).

Furthermore, a temperature control with manipulating intervention in the fuel feed is known. This form of control is superior in control quality to the control of the mass flow of the raw material charge, as can be seen from Fig. 2. The same  
5 disturbance in the material feed to the reactor is compensated for by a change in the fuel mass flow (fuel feed) and leads to the reactor temperature already assuming the desired set point again substantially quicker.

The US 5,226,374 discloses a method of controlling combustion in a fluidized-bed incinerator comprising measuring a supply rate of incineration waste. When  
10 the supply rate of incineration waste is higher than a predetermined value, the supply rate of the incineration waste of the dust feeder is decreased to suppress a combusting operation. Further, i.e. an induced gas rate of an exhaust gas induced blower of the incinerator is increased to suppress an increase in an incin-  
15 erator internal pressure. The supply rate of incineration waste is measured by a measuring unit using a photoelectric element arranged on a shoot for supplying incineration waste.

The JP 55140008 (Patent Abstracts of Japan) describes a high accuracy control  
20 of temperature by measuring the temperature in the fluidized-bed and controlling the amount of floating medium forming the fluidized-bed in order to adjust the temperature.

In the EP 0 093 063 A1 a temperature control of a fluidized-bed reactor is de-  
25 scribed measuring the temperature in the fluidized-bed of the reactor and varying the temperature of the material transported into the reactor by mixing up material out of two conduits with higher and lower temperature. A similar method is employed in the WO 96/18076 A1 describing a gas cooler having a circulating fluidized-bed. Hot gas is introduced into a mixing chamber where it is mixed with  
30 solids having a temperature lower than that of the gas, whereby the temperature

of the mixing chamber settles to a mixing temperature. The mixture of the gas and solids is taken from the mixing chamber via a riser to a solids separator, thereby regulating the temperature of a superheated steam generated in connection with the gas cooling.

5

All of these controls therefore have the disadvantage that a control deviation (temperature deviation) first has to be discovered in the reactor before the energy input can be correspondingly adapted and the control deviation corrected as a result. A further disadvantage is the strong dead-time behaviour of such reactor systems (big masses of brick lining and high product inventory). In some processes, however, even just brief temperature fluctuations lead to losses in the product quality.

10

### Description of the invention

15

Object of the present invention, therefore, is to control the process conditions, in particular the temperature, in a reactor as constantly as possible to a set point predetermined in relation to the process.

20

In a method of the type mentioned at the beginning for controlling e.g. the temperature, this object is essentially achieved in that the material quantity transported in the conveying line is determined and is used as control variable and/or disturbance variable for controlling the process conditions, in particular the temperature. This has hitherto not been conventional practice in the case of granular material, because the determination of the material quantity in a conveying line in the case of granular material is very complicated. However, by virtue of the fact that, according to the invention, the material quantity fed to the reactor

25



is determined in advance, namely in a conveying line to the reactor, and this variable is used directly as control variable and/or disturbance variable for the control, possible fluctuations in the reactor temperature become apparent in advance and can be corrected before a change in the temperature or other process conditions occurs due to the changed material quantity entering the reactor.

5 The method of controlling the temperature in a reactor, according to the invention, is thus also quite generally a method of producing constant process conditions in a reactor, in particular in order to keep the temperature in and/or the material feed to a reactor (material charge introduced into a reactor) of a plant constant.

10 The determination of the material quantity of the material introduced into the reactor consists in the measurement of the pressure and/or of the pressure loss in the conveying line upstream of the reactor. Such a conveying line may in particular be an airlift, with which material is conveyed upwards. The measurement of the pressure or of the differential pressure between start and end of the

15 conveying line of the airlift allows the amount of material which is transported to be accurately deduced. According to the invention, it has been found that this method can be used very accurately even in the case of granular material without recourse to density measuring with radioactive material for example.

20 To this end, according to a practical refinement of the idea according to the invention, the material quantity in the conveying line can be controlled to a predetermined value. In this case, the material quantity is a control variable of the control. The method according to the invention therefore constitutes a control of the material charge introduced into a plant having a reactor in which the material

25 in particular is heated, the material being introduced into the plant via a conveyor for example and being transported by a conveying line directly or via intermediate stages to the reactor, the material quantity in the conveying line being determined and being controlled to a predetermined value. As a result, the material quantity introduced into the reactor is kept essentially constant, so that, in

the reactor, fluctuations in the material quantity which may cause a temperature difference and/or a change in the stoichiometry do not occur or are minimized.

5 The material quantity in the conveying line, in a simple manner, can be controlled by a conveyor, with which the material is introduced into the plant, in particular by varying the rotational speed of a material-charging screw and/or by a weighfeeder (proportional weigher belt) upstream of the material-charging screw. This control eliminates the production-reducing effect of temporary deposits of the material-charging screw for the case where no weighfeeder is pre-

10

be taken into account in the control of the heat supply. In particular if the material is already (pre)-dried when the material quantity is determined, the short dead time until the material is actually introduced into the reactor can be taken into account especially accurately on account of the constant process conditions.

5

A possible material discharge between the determination of the material quantity and the feeding of the material into the reactor is preferably also determined if need be and is taken into account during the control, in particular of the material feed and/or of the heat supply. Such a material discharge may be, for example, a reactor bypass in which material is branched off before the feeding into the reactor and is mixed again with material treated in the reactor after this material treated in the reactor has been discharged. Such a bypass mass flow must be deducted, for example, when determining the heat or fuel requirement.

10

15

In order to reduce disturbing effects when determining the material quantity, in particular due to residual moisture of the raw material introduced, and in order to eliminate the effect of the material moisture during the delivery of the material into the plant, the material may advantageously be dried and/or preheated before the determination of the material quantity in the conveying line. In particular, constant measuring conditions then prevail, so that the effects of the material introduced into the reactor on the temperature prevailing in the reactor can be accurately estimated and taken into account by the control.

20

This control can be used in a multiplicity of reactor types. According to special refinement of the method according to the invention, a gas/solid suspension can form in the reactor, for example as a circulating fluidized bed. In these reactor types, for certain processes, for example calcination, it has proved to be especially important and advantageous that the reactor temperature can be accurately maintained within marginal fluctuations. The methods described above may be used, for example, for the temperature control of a reactor having a circulating fluidized bed during alumina calcination. In particular moist hydrate, for example, can be introduced as raw material into the plant.

The present invention also relates to a plant for the heat treatment of material fed to a reactor, in particular for carrying out the method described above. The plant has a conveying line for the transport of granular material to the reactor and at least one control. According to the invention, the control is connected to a measuring device for determining the material quantity of the granular, in particular fine-grained, material transported in the conveying line to the reactor. As a result, the disturbance variables of a fluctuating material delivery and moisture can be taken into account by the plant control in order to correct the process conditions in advance, in particular the reactor temperature and the material charge introduced into the reactor, and thereby keep the said process conditions constant. The conveying line is a fluid-pressure conveying line, in particular a preferably perpendicularly arranged rising line of an airlift. It has been found that, in contrast to conventional methods of determining the quantity of fine-grained material which is transported in a conveying line, the

**Patent claims:**

1. Method of controlling the process conditions, in particular the temperature, in a reactor (1) of a plant into which, in particular, granular material is introduced and transported through a conveying line (14) to the reactor (1), characterized in that the material quantity transported in the conveying line (14) is being determined and is being used as control variable and/or disturbance variable for controlling the process conditions, in particular the temperature, characterized in that the material quantity of the material fed to the reactor (1) is determined by measuring the pressure and/or the pressure loss in a conveying line (14) upstream of the reactor (1), in particular in an airlift (13).

2. Method according to claim 1, characterized in that the material quantity in the conveying line (14) is controlled to a predeterminable value.

3. Method according to claim 2, characterized in that the material quantity in the conveying line (14) is controlled by a conveyor (27, 33), with which the material is introduced into the plant, in particular by varying the rotational speed of a material-charging screw (30) and/or by a weighfeeder (34) upstream of the material-charging screw (30).

4. Method according to one of the preceding claims, characterized in that the heat supply to the reactor (1) depends on the material quantity determined.

5. Method according to claim 4, characterized in that the heat supply is effected by burning fuel in the reactor (1) and the fuel feed is controlled for controlling the heat supply.

6. Method according to one of claims 4 or 5, characterized in that the reactor temperature is measured in the reactor (1) and the heat supply additionally depends on the reactor temperature determined.

7. Method according to one of claims 4 to 6, characterized in that the time from the determination of the material quantity until the feeding into the reactor (1) is taken into account in the control of the heat supply.

5 8. Method according to one of the preceding claims, characterized in that a material discharge, for example via a bypass line (24), between the determination of the material quantity and the feeding into the reactor (1) is determined if need be and is taken into account in the control in particular of the material quantity and/or of the heat supply.

10

9. Method according to one of the preceding claims, characterized in that the material is dried and/or preheated before the determination of the material quantity in the conveying line (14).

15

~~10. Method according to one of the preceding claims, characterized in that the material quantity of the material fed to the reactor (1) is determined by measuring the pressure and/or the pressure loss in a conveying line (14) upstream of the reactor (1), in particular in an airlift (13).~~

20

140. Method according to one of the preceding claims, characterized in that a gas/solid suspension forms in the reactor (1), for example as a circulating fluidized bed.

25

121. Plant for the heat treatment of material fed to a reactor (1), in particular for carrying out the method according to one of Claims 1 to 11, having a conveying line (14) for the transport of granular material to the reactor (1) and having at least one control (5, 31), ~~characterized by and~~ a measuring device (12) which is connected to the control (5, 31) and is intended for determining the material quantity of the material transported in the conveying line (14) to the reactor (1),  
~~13. Plant according to claim 12, characterized in that the conveying line (14)~~

is a fluid-pressure conveying line, in particular a preferably perpendicularly arranged rising line of an airlift (13).

142. Plant according to claim ~~12 or 13~~11, characterized in that the measuring device (12) is a differential-pressure measuring device for measuring the differential pressure over the conveying line (14).

5    153. Plant according to one of claims ~~12 to 14~~11 or 12, characterized in that the control is a temperature control (5) and/or a material-charge control (31).

164. Plant according to claim 153, characterized in that a temperature sensor (8) connected to the temperature control (5) is arranged in the reactor (1).

10

175. Plant according to claim 153 or 164, characterized in that the temperature control (5) has a control element (6) for controlling a fuel mass flow, directed to the reactor (1) for the combustion, on the basis of the determined material quantity and/or the measured reactor temperature.

15

186. Plant according to one of claims 153 to 175, characterized by a conveyor (27, 33) which is connected to the material-charge control (31) and is intended for the controlled introduction of material into the plant, so that the material quantity in the conveying line (14) can be set to a predeterminable value.

20

197. Plant according to one of claims 121 to 186, characterized by at least one drying device (18, 26) upstream of and/or downstream of the conveying line (14).



JC05 Rec'd PCT/PTO 17 JUN 2005

- 2 -

KEIL & SCHAAFHAUSEN  
PATENTANWÄLTE

Furthermore, a temperature control with manipulating intervention in the fuel feed is known. This form of control is superior in control quality to the control of the mass flow of the raw material charge, as can be seen from Fig. 2. The same  
5 disturbance in the material feed to the reactor is compensated for by a change in the fuel mass flow (fuel feed) and leads to the reactor temperature already assuming the desired set point again substantially quicker.

The US 5,226,374 discloses a method of controlling combustion in a fluidized-bed incinerator comprising measuring a supply rate of incineration waste. When  
10 the supply rate of incineration waste is higher than a predetermined value, the supply rate of the incineration waste of the dust feeder is decreased to suppress a combusting operation. Further, i.e. an induced gas rate of an exhaust gas induced blower of the incinerator is increased to suppress an increase in an incin-  
15 erator internal pressure. The supply rate of incineration waste is measured by a measuring unit using a photoelectric element arranged on a shoot for supplying incineration waste.

The JP 55140008 (Patent Abstracts of Japan) describes a high accuracy control  
20 of temperature by measuring the temperature in the fluidized-bed and controlling the amount of floating medium forming the fluidized-bed in order to adjust the temperature.

In the EP 0 093 063 A1 a temperature control of a fluidized-bed reactor is de-  
25 scribed measuring the temperature in the fluidized-bed of the reactor and varying the temperature of the material transported into the reactor by mixing up material out of two conduits with higher and lower temperature. A similar method is employed in the WO 96/18076 A1 describing a gas cooler having a circulating  
30 fluidized-bed. Hot gas is introduced into a mixing chamber where it is mixed with solids having a temperature lower than that of the gas, whereby the temperature

of the mixing chamber settles to a mixing temperature. The mixture of the gas and solids is taken from the mixing chamber via a riser to a solids separator, thereby regulating the temperature of a superheated steam generated in connection with the gas cooling.

5

All of these controls therefore have the disadvantage that a control deviation (temperature deviation) first has to be discovered in the reactor before the energy input can be correspondingly adapted and the control deviation corrected as a result. A further disadvantage is the strong dead-time behaviour of such reactor systems (big masses of brick lining and high product inventory). In some processes, however, even just brief temperature fluctuations lead to losses in the product quality.

10

### Description of the invention

15

Object of the present invention, therefore, is to control the process conditions, in particular the temperature, in a reactor as constantly as possible to a set point predetermined in relation to the process.

20

In a method of the type mentioned at the beginning for controlling e.g. the temperature, this object is essentially achieved in that the material quantity transported in the conveying line is determined and is used as control variable and/or disturbance variable for controlling the process conditions, in particular the temperature. This has hitherto not been conventional practice in the case of granular material, because the determination of the material quantity in a conveying line in the case of granular material is very complicated. However, by virtue of the fact that, according to the invention, the material quantity fed to the reactor

25

is determined in advance, namely in a conveying line to the reactor, and this variable is used directly as control variable and/or disturbance variable for the control, possible fluctuations in the reactor temperature become apparent in advance and can be corrected before a change in the temperature or other process conditions occurs due to the changed material quantity entering the reactor. The method of controlling the temperature in a reactor, according to the invention, is thus also quite generally a method of producing constant process conditions in a reactor, in particular in order to keep the temperature in and/or the material feed to a reactor (material charge introduced into a reactor) of a plant constant. The determination of the material quantity of the material introduced into the reactor consists in the measurement of the pressure and/or of the pressure loss in the conveying line upstream of the reactor. Such a conveying line may in particular be an airlift, with which material is conveyed upwards. The measurement of the pressure or of the differential pressure between start and end of the conveying line of the airlift allows the amount of material which is transported to be accurately deduced. According to the invention, it has been found that this method can be used very accurately even in the case of granular material without recourse to density measuring with radioactive material for example.

To this end, according to a practical refinement of the idea according to the invention, the material quantity in the conveying line can be controlled to a predeterminable value. In this case, the material quantity is a control variable of the control. The method according to the invention therefore constitutes a control of the material charge introduced into a plant having a reactor in which the material in particular is heated, the material being introduced into the plant via a conveyor for example and being transported by a conveying line directly or via intermediate stages to the reactor, the material quantity in the conveying line being determined and being controlled to a predeterminable value. As a result, the material quantity introduced into the reactor is kept essentially constant, so that, in

the reactor, fluctuations in the material quantity which may cause a temperature difference and/or a change in the stoichiometry do not occur or are minimized.

5 The material quantity in the conveying line, in a simple manner, can be controlled by a conveyor, with which the material is introduced into the plant, in particular by varying the rotational speed of a material-charging screw and/or by a weighfeeder (proportional weigher belt) upstream of the material-charging screw. This control eliminates the production-reducing effect of temporary deposits of the material-charging screw for the case where no weighfeeder is pre-

10

be taken into account in the control of the heat supply. In particular if the material is already (pre)-dried when the material quantity is determined, the short dead time until the material is actually introduced into the reactor can be taken into account especially accurately on account of the constant process conditions.

5

A possible material discharge between the determination of the material quantity and the feeding of the material into the reactor is preferably also determined if need be and is taken into account during the control, in particular of the material feed and/or of the heat supply. Such a material discharge may be, for example, a reactor bypass in which material is branched off before the feeding into the reactor and is mixed again with material treated in the reactor after this material treated in the reactor has been discharged. Such a bypass mass flow must be deducted, for example, when determining the heat or fuel requirement.

10

In order to reduce disturbing effects when determining the material quantity, in particular due to residual moisture of the raw material introduced, and in order to eliminate the effect of the material moisture during the delivery of the material into the plant, the material may advantageously be dried and/or preheated before the determination of the material quantity in the conveying line. In particular, constant measuring conditions then prevail, so that the effects of the material introduced into the reactor on the temperature prevailing in the reactor can be accurately estimated and taken into account by the control.

20

~~An especially preferred possibility according to the invention for determining the material quantity of the material introduced into the reactor consists in the measurement of the pressure and/or of the pressure loss in the conveying line upstream of the reactor. Such a conveying line may in particular be an airlift, with which material is conveyed upwards. The measurement of the pressure or of the differential pressure between start and end of the conveying line of the airlift allows the amount of material which is transported to be accurately deduced.~~

25

30

~~ced. According to the invention, it has been found that this method can be used very accurately even in the case of granular material without recourse to density measuring with radioactive material for example.~~

- 5 This control can be used in a multiplicity of reactor types. According to special refinement of the method according to the invention, a gas/solid suspension can form in the reactor, for example as a circulating fluidized bed. In these reactor types, for certain processes, for example calcination, it has proved to be especially important and advantageous that the reactor temperature can be accurately
- 10 maintained within marginal fluctuations. The methods described above may be used, for example, for the temperature control of a reactor having a circulating fluidized bed during alumina calcination. In particular moist hydrate, for example, can be introduced as raw material into the plant.
- 15 The present invention also relates to a plant for the heat treatment of material fed to a reactor, in particular for carrying out the method described above. The plant has a conveying line for the transport of granular material to the reactor and at least one control. According to the invention, the control is connected to a measuring device for determining the material quantity of the granular, in parti-
- 20 cular fine-grained, material transported in the conveying line to the reactor. As a result, the disturbance variables of a fluctuating material delivery and moisture can be taken into account by the plant control in order to correct the process conditions in advance, in particular the reactor temperature and the material charge introduced into the reactor, and thereby keep the said process conditions
- 25 constant.

~~According to a special embodiment, the~~ The conveying line is a fluid-pressure conveying line, in particular a preferably perpendicularly arranged rising line of an airlift. It has been found that, in contrast to conventional methods of determining

30 the quantity of fine-grained material which is transported in a conveying line, the